

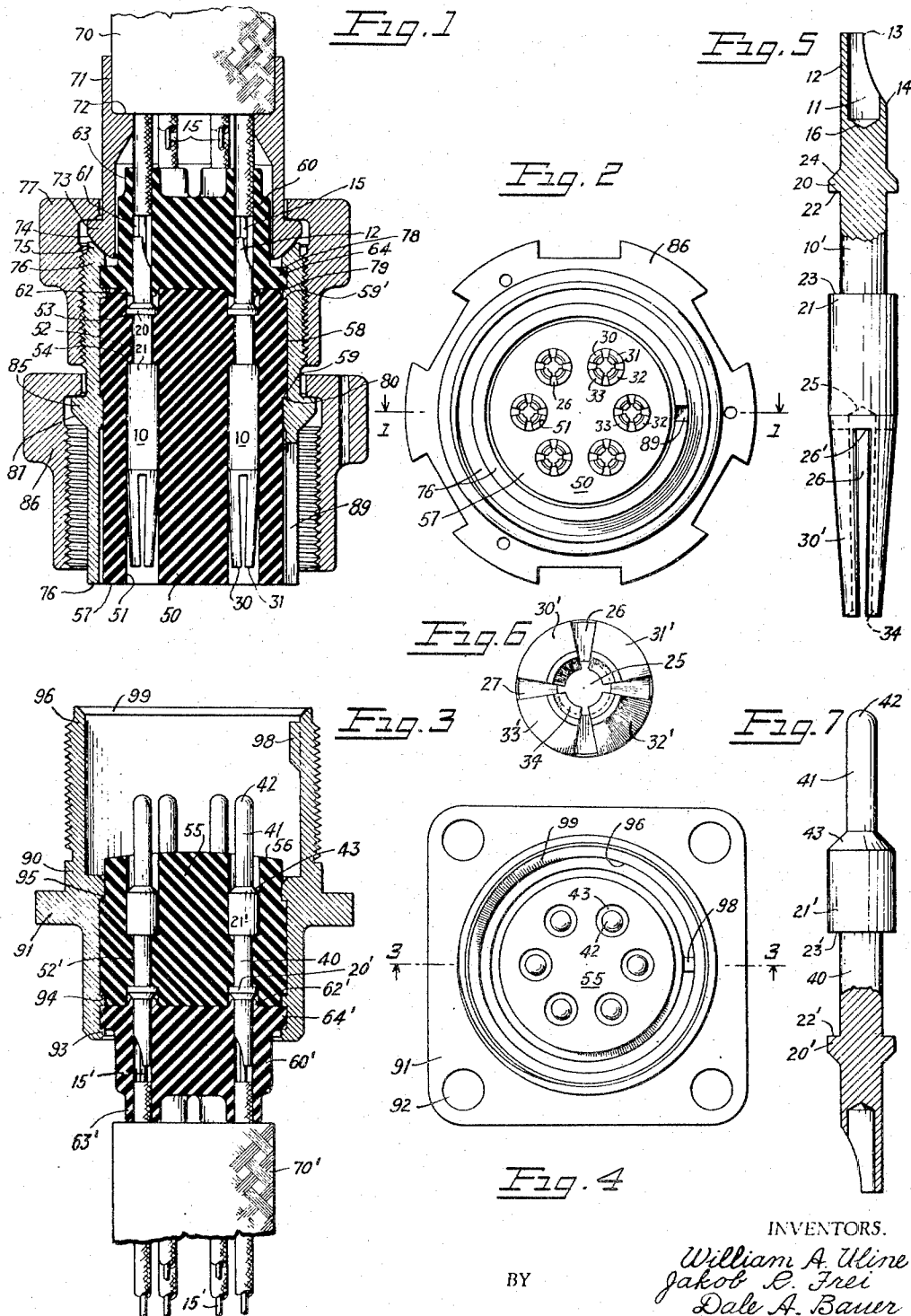
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ELECTRICAL CONNECTOR HAVING RESILIENT INSERTS

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ELECTRICAL CONNECTOR HAVING
RESILIENT INSERTS

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This invention relates to electrical connectors, and particularly to means of the plug and jack or pin contact and socket contact type for connecting electrical conductors.

It is an object of the invention to make a connection that will mechanically and electrically shield a pin and socket so that vibration will not jar the connection loose or destroy the electric shielding.

Another object of the invention is to mount a pin and socket in resilient mountings under compression in order to support and protect the connection between them.

Another object is to mount a pin and socket in shells or casings so that the casings may interchangeably mount either the pin or the socket.

Another object is to assemble a plurality of pins in a novel mount so that they will be freely self-aligning with similarly mounted sockets.

Another object is to prepare pin and socket contacts having resistance approaching that of copper wire and having surface contact producing a minimum amount of heat on the passage of a current.

Another object is to prepare spring sockets that retain their resilience at temperatures harmful to the resilience of prior art sockets, and that are capable of retaining their resilience at temperatures materially higher than that employed in preparing them.

A further object is to make a novel socket having spring fingers adapted to make contact with broad surfaces of a pin along substantial lengths of the telescoped parts.

A further object is to mount pins and sockets removably in connectible metal shells in inserts of resilient type adapted to align, support, protect, and seal the connection and all its parts.

A still further object is to employ a resilient mount for pin and socket connections that permits natural floating of the pin and socket during the making of the connection.

The above and further objects and novel features of the invention will more fully appear from the following detailed description when the same is read in connection with the accompanying drawings. It is to be expressly understood, however, that the drawings are for the purpose of illustration only, and are not intended as a definition of the limits of the invention, reference for this latter purpose being had primarily to the appended claims.

In the drawings, wherein like reference characters refer to like parts throughout the several views,

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Fig. 1 is a longitudinal section through the socket shell showing the socket and socket inserts in place, taken on the line 1—1 of Fig. 2;

Fig. 2 is an end view of the embodiment shown in Fig. 1 showing the ends of six sockets mounted in the socket insert;

Fig. 3 is a longitudinal section through the pin shell showing the pins and pin insert in place, taken on the line 3—3 of Fig. 4;

Fig. 4 is an end view of the device of Fig. 3 showing the contact pins mounted in the insert;

Fig. 5 is an enlarged plan view, partly in section and with parts broken away, of a preferred form of socket;

Fig. 6 is a greatly enlarged end view of the socket shown in Fig. 5, showing the ends of the contact fingers or prongs; and

Fig. 7 is an enlarged view, partly in section and with parts broken away, illustrating one form of pin that may be employed.

The invention embodies, among other features, a novel pin and socket that have superior characteristics, particularly for use under conditions that subject the connection to abuse, to strains, particularly those that tend to break the connection at the joint, and to destructive forces such as heat, blows, or intense vibration. That pin and socket connection is claimed in a copending application filed of even date herewith, but its properties and construction form a part of the combination of this invention and will be described here. One form of the novel pins and sockets is found in Figs. 1 and 3. In these figures 10 represents a socket and particularly the body portion thereof. This socket is preferably an integral structure having a well, abutments, and contact fingers. It may be made of any satisfactory, electrically conductive material but is preferably made of beryllium copper, silver plated on contact surfaces. The metallurgical constitution of this socket is novel in itself, and the constitution of the socket in combination with the constitution of the pin is also novel. At one end of the socket a solder well is provided, the nature of which can best be comprehended from a consideration of the well 11 of Fig. 5, which is identical with the construction employed in the pin and socket of Figs. 1 and 3. The well consists of a hole 11 drilled or otherwise formed in the end 12 of the socket and having a portion of one side wall removed from points 13 at the end of the socket to a point 14 on the side thereof. The opening in the side of the well gives access to the well so that the end 15 of a wire may be inserted and soldered in place without difficulty.

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The bottom of the well 11 is conical in shape as shown at 16 in order that the wire may be centered in the well before soldering. The well extends below the point 14 so that the solder has circumferential attachment to the wall of the well. By this means a positive and permanent connection between the electric wire and the pin or socket is assured. In large elements, the cut side may be omitted from the well.

Novel abutments are provided on the pins and sockets to provide for resiliently mounting them in the resilient inserts that constitute further novel parts of the invention. These abutments may have square shoulders to hold them in place and beveled surfaces to assist in inserting them in the inserts. Alternatively, the pins and sockets may be molded in the respective inserts, although it is preferred to make them mountable, or dismountable.

The abutments on the socket shown in Fig. 5 will be described as representative. In Figure 5 the body portion 10' of the socket is provided with abutments 20 and 21 which are annular and have plane surfaces 22, 23 facing each other. The abutment 20 has a conical surface 24 toward the well end of the socket. The surface of the abutment 21 is continued cylindrically toward the fingered end of the socket, the fingers of which constitute in effect a conical surface adapted to aid in mounting the socket in the novel rubber inserts.

Referring more particularly to Figs. 1 and 2, the contact elements or fingers of the socket 10 are preferably integral with the socket. One method of manufacturing a socket with such fingers consists in cutting an annular groove in the body 10' of a beryllium-copper rod, turning down the end 12 of the rod cylindrically, and the end 30' conically. The end of the rod is drilled to a depth indicated by the dotted lines 25 in Fig. 5 to a diameter slightly larger than the pin, .001 to .003 clearance being satisfactory. The bored end of the rod is then milled to provide longitudinally extending slots 26, 27 (Fig. 6) extending to a depth preferably, but not necessarily, somewhat less than the depth of the central bore, as indicated at 26' in Fig. 5. The bore is then burnished to remove burrs. There are thus provided 2, 3, 4 or more fingers each of which has cylindrical inner and outer surfaces joined by flat sides. The fingers so formed are now bent toward each other by a tool that engages them near the base so that they assume the relation shown in Figs. 1, 2, 5 and 6, and are fixed in that position. This formation can be made by applying cold bending pressures to the fingers near the ends of the slots with a subsequent heat treatment at about 575° F. The sockets so formed as shown in Figs. 5 and 1 have four fingers 30, 31, 32 and 33 which inherently possess spring properties and are capable of gripping a pin so that material forces may be required to withdraw it from its socket, from about one half to two pounds being required with a #16 contact and 15 to 20 pounds with a #0 contact. The construction of the fingers and their conformation may be varied to vary the degree of force needed to withdraw the plug, so that either greater or lesser forces than those stated may be required. By appropriate methods of formation a greater or lesser number of fingers may be provided.

In very small sockets the fingers may have little or no taper, but in other sizes it is preferred that they be tapered in order that the fingers

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may curve to conform to the pin throughout their overlapped areas. In the form shown in Fig. 5, the fingers 30', 31', 32', and 33' are tapered from the base toward the point, thus providing flexibility that increases from their bases to their points, so that upon insertion of the jack, the flexing of the fingers begins at the point and proceeds upwardly along the fingers as the point of the pin is advanced. When emplaced, the pin is preferably not inserted to the base of the socket but only part way, so that the set of the fingers is not destroyed at their bases. This tapered form has great advantages in securing contact and equal gripping interaction between all portions of the overlapped telescoped body of the socket. This modified form of socket as so constituted is a major improvement over other forms of sockets.

The novel pins, adapted for cooperation with the sockets that have just been described, are preferably made of tellurium copper, silver plated on each contact face, and comprise a body portion 40 (Figs. 3 and 7) having at one end a well similar to that which has been described and at the other end a cylindrical pin or prong 41 having a rounded end 42 adapted to cooperate with the internal bevels 34 in the ends of the socket fingers to spring the said fingers apart in seating the pin. The main portions of the pin have abutments 20' which are identical with abutments 20 of the sockets in size and conformation, and abutments 21' which differ from abutments 21 only in being reduced by a conical face 43 at the end of the pin 41. The distance between the facing planar surfaces 22', 23' of the abutments 20' and 21' is equal to the distance between the facing planar surfaces of abutments 20 and 21 so that the sockets and pins are interchangeable in their resilient inserts.

A novel feature of this invention consists in mounting the novel pin and socket resiliently within protective shells but so that the resilience of the mounting can be availed of to improve creepage and flashover conditions. In addition to this broad and general inventive concept this novel mounting means embodies a number of new and useful conceptions and improvements the nature of which will be set forth or will be deducible from the structure as the description proceeds.

Mounting means comprises an insert 50 of rubber or like resilient material is provided for the sockets 10. This insert is provided with holes 51 which extend from end to end thereof but which are reduced at a place 52 within the insert or block to provide a plurality of annular shoulders 53, 54 adapted for seating between abutments 20 and 21 of the socket. The holes 51 may be of size equal to the size of the abutments or somewhat smaller, a slightly lesser diameter being preferred in order to insure the firm contact of the rubber insert 50 with the body and the abutments of the socket. Inasmuch as the abutments 20 and 21 and 20', 21' are equally spaced, either the pin or the socket may be mounted in the insert 50. The insert 50 preferably extends beyond the points of the socket fingers as shown in Fig. 1, or beyond the end of the pin, the relative extent of inserts 50 and 55 being selectable to adapt the structure to particular circumstances.

An insert 55 of resilient mounting material, such as natural rubber or synthetic rubber, serves to mount the pins 40, being provided

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with holes having reduced portions 52' substantially equal in extent to the reduced portions 52 of the space between the abutments. Insert block 55 is shown in Fig. 3 as of less length than the insert block 50 and having a spherical face 56 adapted to make contact with the planar face 57 on the block 50, and by reason of its spherical form to squeeze moisture and air out of the connection. The pins and sockets may be molded into the inserts if desired. One of the inserts may be made of flexible and the other of comparatively rigid material consistent with the requirements of insertion in the shells and reception of the pin or socket.

The resilient inserts are of columnar type and are compressively engaged with the metal shell for a substantial part of their length, as indicated in Fig. 1, engaging land 59', groove 52, and the land at 80, but the remainder of the insert is circumferentially spaced from the shell as shown between numbers 57 and 76 in Fig. 1 and Fig. 2. This space permits the rubber, which is incompressible, to flow so that the engaged faces of the inserts 50-55 can accommodate each other and form a perfect seal. As the shells are drawn together the rubber fills the space so that as the end 99 seats upon the ring 87 the contacts are firmly but resiliently supported in every direction.

The land formed at the middle of the shell constitutes a constriction through which the entire land 58 has to be forced to dismantle the parts. This can only be done by slow pressure, as a sudden thrust defeats its purpose. The land cannot be folded over, and must be caused to flow progressively through the constriction.

The well ends of the pins and sockets are seated in substantially identical grommets or protective sleeves 60, 60', the description of one of which will suffice. These sleeves, and inserts 50, 55 are made of rubber or synthetic rubber or some other resilient dielectric material having holes 61 extending from end to end thereof and through conical bosses 62 and cylindrical bosses 63. The holes 61 are preferably the size of the wire and less than the diameter of the well end of the pins, or sockets, so that firm and protective contact will be offered throughout the telescoped lengths thereof and particularly at the soldered connection to prevent vibrations from breaking the comparatively inflexible soldered joint. The conical bosses are adapted to be seated in the ends of the holes 51 in the inserts 50, 55 and to make firm and sealing contact with the edges thereof. The sleeves 60 and 60' have annular flanges 64 and 64' of equal size which may be bevelled at the leading edge for seating purposes if desired.

The outer surface of the insert 50 is provided with an annular raised land 58 which has a planar abutting face 59 at one end and a conical face 59' adapted to aid in mounting in the shells, at the other end. The lands are of equal size in inserts 50 and 55 and are equally spaced from one end of the insert in order to adapt the inserts to interchangeable mounting in the protective shells to be hereinafter described.

It is desired to give the structure heretofore described mechanical protection against separation and damage and also electrical protection, in order that electrical emanations from other sources may not affect the connection and so that electrical emanations from the connections may not affect other electrical instrumentalities. In order to accomplish this, novel protective and

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shielding means are provided and now will be described.

As shown in Fig. 1 the sockets are enclosed in a four-part metallic socket shell possessing a number of novel features. The shell may be made of aluminum or other metals, or if electrical shielding is not of the essence, of strong inert material such as phenol-formaldehyde resin or other strong organic materials capable of forming to the desired shape. The shielded conduit 70 which carries the insulated wires 15 inside it has its end received within a ferrule or collar 71 forming a part of the protective shell and internally provided with a shoulder 72 upon which the end of the conduit is adapted to rest. The other end of the ferrule 71 is provided with an annular flange 73 having a spherically bevelled surface 74 adapted to be seated within a conical surface 75 of a sleeve 76 that forms the basic protecting and aligning member of the socket shell. The abutting faces of the ferrule 71 and the sleeve 76 are held in contact by a screw threaded clamping ring 77 which is mounted on the member 76 and overlaps flange 73, as shown in Fig. 1. By tightening the clamping ring 77 upon the flange 73 a spherical surface of the flange is brought into electrically and mechanically sealing relation to the end of member 76, thereby providing line contact and an excellent radio-shielding joint.

The sleeve 76 is internally provided with annular abutments 78, 79, 80 adapted to seat the land 58 and the flange 64 of the insert 50 and sleeve 60, and is externally provided with an annular flange 85 designed to afford a purchase for the clamping ring 86, and with a spherically bevelled surface 87 similar to surface 74. The sleeve 76 is also provided with a slot 89 which guides the mechanic in aligning or orienting the insert 50 and its assembled contacts within the shell, and aligns the cooperating member 96 of the shell to insure desired connections between the various pins and sockets.

The mounting for the sockets, as above described, is constructed for cooperation with a mounting for the pins. This latter mounting is shown in Fig. 3 and comprises a single metallic sleeve 90 having an annular flange 91 for mounting the connection upon a support, as by means of holes 92 (Fig. 4), and being internally provided with annular abutments 93, 94, 95 for the inserting of sleeve 60' and insert 55. Abutments 93 and 95 may be provided with bevelled outside edges, as shown, to assist in inserting the inserts. The sleeve projects at 96 beyond the pins 41 for cooperation with clamping ring 86 and is internally provided with a lug 98 for cooperation with the slot 89 in the sleeve 85. The end of the sleeve projection 96 is internally conically bevelled at 99 for line contact against the spherical surface 87 of the flange 85.

In one method of assembling the connection which has thus been described, the insulated wires 15 are pulled through the cable member 70', if one is used at this end of the connector, the ends of the wires are cleaned, as will be understood by electricians, and drawn through the holes in the sleeve member 60', and through the sleeve 90. The ends of the wires are then seated in the wells at the ends of the pins and soldered in place before insertion of the pins into inserts 55. The pins are then forced into position in insert 55 with the aid of the bevels 43 of the abutments 21'. The insert carrying the emplaced plugs is now forced into the sleeve

90 past cooperating bevels as shown in Fig. 3. Any alternative and satisfactory method of assembly may be used, for instance, to put the insert in the sleeve and force the pins into place. The sleeve 60' is then inserted between the abutments 93 and 94 past cooperating bevels, and the conduit 70' is brought into abutting or overlapping relationship with the boss 63' or sleeve 90. In seating the insert the pins must be brought into a definite relation to the lug 98, two of the pins in Fig. 4 being shown as in diametrical alignment with the said lug. This alignment should preferably be within 30 minutes of arc and may be accomplished by any of many suitable known methods, such as by reference marks or interfitting tongues and grooves on inserts 55, and shell member 90. In assembled relation the adjacent faces of insert 55 and sleeve 60' are in firm engagement and the conical bosses 62' fit snugly into the holes through block 55.

In a similar manner, the wires 15 are drawn out of the conduit 70 and through the cooperating shell members, and through the sleeve before being secured in the solder wells of the sockets 10. The sockets are then inserted in the insert 50 until the land 52 is seated between the abutments 20 and 21. If desired, of course, the sockets may be mounted in insert 50 by forcing the latter over the conically shaped pronged end of the socket. The sleeve 76 is then mounted upon the insert assembly with the aid of cooperating flanges 79, 80 and the sleeve 60 is emplaced in a manner similar to the emplacement of sleeve 60'. The ferrule 71 is then mounted on the end of the sleeve by connecting ring 77. The insert 50 must be mounted in proper angular alignment or orientation with the slot 89 in a pre-determined relation and preferably within 30 minutes of arc as described for the pins in relation to the lug 98. The corresponding openings in the inserts may be lettered or numbered for the convenience of the electrician. As in the plug portion of the joint, the adjacent faces of insert 50 and sleeve block 60 are in firm engagement when said blocks assume the illustrated positions in shell member 76 and bosses 62 are squeezed into openings 51. Also, the surfaces 74, 75 are brought into firm engagement to provide a moisture tight seal and a good radio shielding joint.

In making the connection between sockets and pins the lug 98 is aligned with the slot 89 and the sleeves 76 and 96 are telescoped, bringing the pins 42 in alignment with the sockets. The pins and sockets can now be telescoped, and the connection made substantially permanent, by rotating the ring 86 until the faces 57 and 56 of the inserts 50 and 55 abut. By applying further pressure through the ring 86, the blocks 50 and 55 can be put under compression in order to increase the firmness with which the plugs and jacks are held and to provide a tight joint to eliminate moisture and perfect the sealing. If lubricant is used to aid in seating the blocks, it should be of dielectric type and be kept off the solder well.

An advantage of this invention is the provision of strong and well protected connections between electrical line terminals and shielding conduits therefor in which the protection is both mechanical and electrical. Another advantage is the provision of resilient mountings for electrical connections, the resilience of which can be altered to suit the circumstances of use. An-

other advantage of the invention is the provision of a mounting which is more lasting under conditions of severe vibration. Another advantage is a superior electrical connection by jacks and plugs in which contact is maintained substantially throughout the telescoped lengths thereof. Another advantage is in the superior metallurgical construction of the parts. Additionally, the connection provided is waterproof and insures against electrical and magnetic emanations which interfere with radio reception. The novel construction provided also provides substantial assurance against flashovers between adjacent conductors. Yet another advantage of the invention arises from the overlapping and interfitting of the sleeves 76 and 96, which prevent the bending and breaking of the connection at the joint.

Other advantages will be apparent to persons skilled in the art.

Although only one embodiment of the present invention is herein illustrated and described, it is to be expressly understood that the same is not limited thereto. Various changes may be made therein, particularly in the design and arrangement of the parts illustrated without departing from the spirit and scope of the invention, as will now be apparent to those skilled in the art.

What is claimed is:

1. An electrical connector including two rigid, annular metal shells having snugly interfitting ends and circular opposed surfaces providing internal metal to metal electrical shielding in assembled relation, aligning means having a part on each shell for aligning the shells, means to hold the said ends together in interfitting relationship, resilient dielectric inserts compressively fitted to the inside of each said shell and having opposed faces adapted to make sealing contact with each other, said inserts having holes for the reception of electrical connectors, plug and socket electrical connectors compressively and cooperatively mounted in the said holes, said connectors in each said insert being aligned with the respective parts of said aligning means, a cooperating circumferential land and groove formed in the bodies of each said shell and its insert, at least one of said inserts being circumferentially spaced from its shell adjacent to its said opposed face, and a cooperating circumferential land and groove formed in the bodies of each insert and its compressively held connectors, the inserts in said shells meeting and being subject to compression against each other when the shells are joined by said holding means.

2. An electrical connection comprising connectible shells having one-piece, telescoping cylinders with elemental aligning means, means within and integral with each said shell receiving and retaining a resilient mounting insert, eccentrically positioned means within each said mounting insert receiving and retaining one member of a pin and socket connection, cooperating elemental aligning means in the inserts and shells, said mounting inserts being of such size and construction that abutting faces thereof may be held under sealing compression about said members when said pin and socket are electrically connected, and at least one of said inserts being circumferentially spaced from its shell, adjacent to its said abutting face.

3. An electrical connector including cooperating contacts of pin and socket type, resilient dielectric inserts having holes in which said contacts are mounted and having opposed faces

adapted to make sealing contact about said contacts, said inserts and contacts having compressively interfitting lands and grooves cooperating to yieldably hold the contacts in the inserts, rigid one-piece protective shells surrounding said inserts, said shells and inserts having lands and grooves cooperating to yieldably hold said inserts in the shells, said connector being provided with circumferential space, between a said shell and its said insert, adjacent the said opposed face to permit radial flow of the insert under pressure, insulated conductors connected to the remote ends of said contacts outside the inserts, and resilient protective dielectric sleeves mounted in said shells around the end portions of said conductors and extending into compressive relation with said inserts.

4. An electrical connection including a pair of rigid shells having ring shaped meeting faces, means for drawing said shells axially together into sealing relationship of said faces, resilient inserts, having cooperating, opposed faces, seated in said shells, an internal, square shouldered, circumferential constriction in each said shell conforming to a like external constriction in its insert, an electrical connector having pin and socket parts mounted in said inserts, a said shell being spaced from its said insert circumferentially adjacent the said cooperating face of said insert, providing the insert with space for radial expansion under endwise compression by its cooperating insert.

5. An electrical connection including rigid protective shells, resilient inserts, having opposed, engageable faces, mounted in said shells, cooperating electrical contacts mounted in said inserts, said shells, contacts and inserts having cooperating lands and grooves, means for joining said shells and for placing said engageable faces under pressure, and a cylindrical expansion space into which the resilient material of a said insert may flow when pressure is applied extending inward from a said engageable face.

6. In an electrical connector the combination of a rigid one-piece tubular shell, a resilient insert closely interfitted in said shell and having at least one longitudinal opening therethrough for receiving a contact, said shell and insert hav-

ing means for yieldably holding the insert in the shell, a contact mounted in said opening, said connector being provided adjacent its forward end with an inwardly extending space into which the material of the resilient insert may flow laterally when subjected to endwise pressure.

7. An electrical connector element including a rigid one-piece shell, a resilient columnar dielectric insert having a major part of its length closely fitted in said shell and an end part of lesser diameter spaced from said shell, and a land in the shell abutting the end of the closely fitted part of the insert, said land being formed in the shell and constituting a constriction through which a material length of the body of the insert must be squeezed in dismantling the element.

8. An electrical connector including a contact, a resilient dielectric support encompassing and supporting said contact and having a perforated face giving admittance to said contact, a rigid shell encompassing said support and holding said support under compression, said connector having a recess extending inward from said face into which the material of the support may flow when pressure is applied to said face.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
739,707	Park	Sept. 22, 1903
1,686,534	Rosenzweig	Oct. 9, 1928
2,265,341	Borchert	Dec. 9, 1941
2,275,762	Horton	Mar. 10, 1942
2,276,017	Brownstein	Mar. 10, 1942
2,286,952	Cannon et al.	June 16, 1942
2,291,793	Chandler	Aug. 4, 1942
2,346,831	Drury	Apr. 18, 1944
2,352,159	Brodie	June 27, 1944
2,371,551	Schmitt	Mar. 13, 1945
2,379,942	Webber	July 10, 1945
2,383,926	White	Aug. 28, 1945